Title: Python in ArcGIS Pro

1. Critical Resources:

Internet connected computer, ArcGIS Pro, week 6 lab videos available on myCourses.

2. Purpose:

The purpose of this lab will be for you gain experience and knowledge (a) downloading data from the US Census Bureau, (b) using data from the Living Atlas, (c) Building a geoprocessing task using Model Builder, (d) using Python variables and syntax in the ArcGIS Pro field calculator.

3. Learning Objectives – After completing the lab, you will know:

- How to create a geoprocessing task using Model Builder
- How to use Python in the field calculator to batch update attributes
- How to download and modify data found in the Living Atlas

4. Deliverables:

You will submit a Word DOCX file to Assignments > Lab 6 – Python in ArcGIS Pro.

Steps

1. Task – Design analytical questions

For the first task, you are going to think of 2 separate questions that you want to ask of the data. We will be using 2 datasets:

1. Census Bureau (ACS Boundaries) found in the Living Atlas
2. Features layer from the US Census TIGER website (https://www.census.gov/cgi-bin/geo/shapefiles/index.php)

You will need to choose 1 of the ACS Boundaries datasets (ex. Poverty, Population, Housing). You will also need to choose 1 'Features' layer, either **Roads, Rails, or Landmarks** from the US Census Tiger website.

The 2 datasets/questions do not need to be related. They can be independent.

1. **Task 2** - For the ACS data, you will be populating values in a new field using Python. In the videos and exercises you have seen some of the ways that Python can be of use in a GIS. For me, the most important use case has been data management. Using whatever dataset you choose; you must create a new field and then populate it with values using a Python expression in the field calculator. (Task 2 walks through this)
2. **Task 3** – For the US Census TIGER data, you will be asking a spatial question of the dataset using model builder. I would recommend watching the lab video walk-through to see some examples.

I have left the datasets and questions very open for this lab on purpose. Hopefully, you can use some of these tools, methods, or data for your final project as well.

2. Task – Programmatically create attributes with Python

2.1 Start a new project and load data

In ArcGIS Pro, go to the Living Atlas and search for ACS data. Any of the 'ACS boundaries' datasets will work (Poverty, Race, Housing Costs, etc.).

After you add the dataset to your map, you need to create a copy of the dataset to allow you to edit it.

Right-click on the layer and choose Data >> Export Features. *Tip: To limit the amount of data that you export, under the 'Environments' setting of the tool, set the Processing Extent to 'Current Display'. Another Tip: Use the "Select By Attributes" to narrow down to a specific state or county.*

2.2 Create a new field

Open the attribute table for your data. Look through the fields. Is there another set of attributes that you want to explore or visualize? Create a new field in your dataset (ensure that you set it to the right data type: text, double, etc.).

One potential tool that you could use, is the Data Engineering tool, which allows you to look at the distribution of different attributes in your data.

You could also symbolize your data to look at the different classes and distributions that get generated.

2.3 Build a Python expression

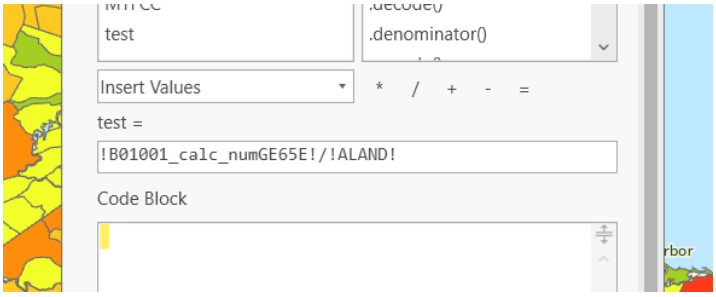
For this task, you only need to create one (1) Python expression for your submission, but I have included three (3) examples here to provide you with some ideas of what is possible. **Do not use the exact same data and expression.**

I provided the 3 examples because I have found that these are some of the most useful use cases for Python in GIS. If you are new to Python, just work through these slowly and play around. If you know Python, try to push yourself with a more complex expression (multiple nested loops? Multiple functions?).

With the attribute table open, right-click on your new field and select 'Calculate Field'.

Example 1 – simple math

If I wanted to calculate the Population Per Sq. Mile or KM, I could enter:



This expression is taking the value in the first field, !B01001_calc_numGE65E! (Population over 65) and dividing it by the value in the !ALAND! field (area of land). Just some basic division!

There are a wide-array of options for these kinds of simple calculations, including ratios, percentages, adding multiple fields together, etc. Test some things out!

Example 2 – Creating Classes
This example is a little more complex because it involves building a function, but it is an incredibly useful skill to have.

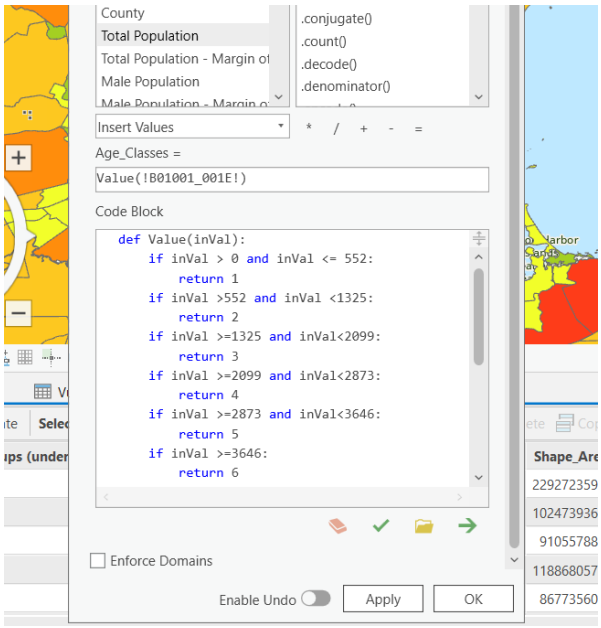
For the Population ACS data, I wanted to create defined classes of the vulnerable population (those under 18 and over 65). After looking at my data, 6 different classes (or buckets) based on the Standard Deviation is my goal.

To do this, I needed to utilize the Code Block in the Calculate Field tool to create a simple function.

First, I need to define the function and pass in a field value.

I called my function ‘Value’ and then double clicked ‘Total Population’ to pass those values into the function (!B01001_001E! is the field name).

In the Code Block, I then need to define the function. In the function I created a variable called ‘inVal’ (in value), which will take the value from the field that we are passing in. In this function, I am taking the variable and passing it through ‘if’ statements. When the variable meets the criteria… it will get that value (Look at my expression below… If the Total Population is 1,453… what value would be assigned?).

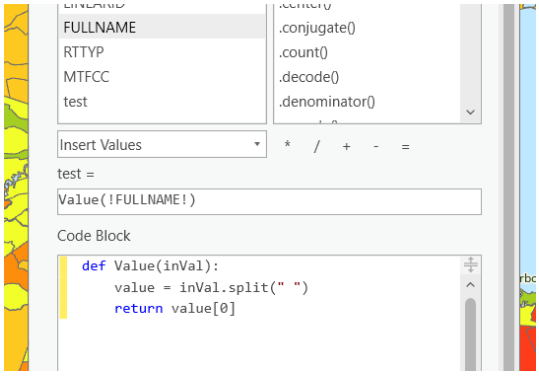


Example 3 – Built-in Functions
Instead of building your own function to create classes, you can also use the long list of math and logical functions that are included in the Calculate Field pane.

In this example, I only want a portion of some data that has all been jammed into one (1) field. If there is a field that contains full names (Stan James Smith), but I only want the first name, how could I just select that part of the field?

First, I need to give my function a name (I gave it the name 'Value' again, but this could be called anything) and I pass in a field value.

In the Code Block, I am creating a new variable called 'value' and then using a string function. This function will look for spaces (" ") in my inVal variable, and then break these up into a list. In the final line of my code, I am 'returning' the first item in the list



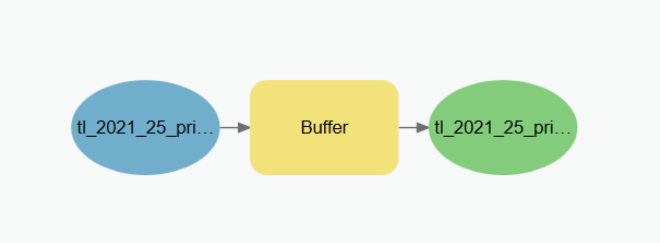
To look at more example of functions and to get other ideas for your expression, refer to this documentation: https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/calculate-field-examples.htm

Make sure that you take a screenshot of your Python Expression for the lab submission.

3. Task – Use ModelBuilder to automate a workflow

As you have already seen in the videos and exercises, ModelBuilder is an environment for automating workflows visually inside of ArcGIS Pro. You have the ability to connect multiple tools and outputs together.

One simple example of this is creating a buffer. If you wanted to create 5 different buffers of a road to gauge the impact of noise, pollution, or runoff. Rather than running the same tool multiple times to get an output, you can design a model that can be shared, or used with other datasets as an input.



Example that shows the input (blue oval), the tool (yellow rectangle), and the output

For Task 3, you will be creating a model, using the US Census Tiger dataset. Your model needs to have **at least 3 tools** (rectangle shape).

Do not use the exact same data, location, and model that I do in my example.

3.1 Get your data

You will need to choose 1 'Features' layer, either **Roads, Rails, or Landmarks** from the US Census Tiger website (https://www.census.gov/cgi-bin/geo/shapefiles/index.php)

Create a new map in your ArcGIS Pro project and add the data.

3.2 Create a Model

Under the analysis tab, go to ModelBuilder to open this tool. After opening the tool, a blank canvas will appear.

Start by selecting your layer in the table of contents and dragging it onto the canvas. It should now appear as a blue oval. This is an 'input'.

By going to the Analysis tab, and searching for a tool (I recommend starting with Buffer to test with, because it's an easy one to see your results quickly). Now, click

on your 'input' data and drag an arrow to connect to the tool. When prompted select 'Input'.

Lastly, double click on the Buffer rectangle in ModelBuilder to configured the parameters for the tool. After you fill in the required parameters, the rectangle should turn yellow to let you know it's ready to run.

Lastly, right click on the green oval (the output) and click 'Add to Display'.

Now at the top of the screen in the ModelBuilder ribbon, click Validate to reset the model and verify if everything is configured, and then click Run.

The geoprocessing status dialog will now open and show you what the current status of your model is. When it completes, it will add the result to your map.

Using buffer is just one (1) simple example to get you familiar with the interface. For your submission, you will need to chain at least 3 tools together (you can use more). After a process runs (like buffer in this case) you could then have that result get passed into another tool.

A model or a script is a common example of what researchers and academics will build out and share with their work. Think of ways that a model could potentially be incorporated into your final project.

Deliverable(s)

1) Please include responses to the following questions inside of (1) MS Word document that gets uploaded under Assignments > Week 6 > Lab 6 – Python in ArcGIS Pro:
    a. Describe and discuss your 2 research questions
    b. Include a list of the datasets that you used for your analysis (name and source) for both Task 2 and Task 3
    c. Include a screenshot of the Python expression that you used in the Calculate Field window.
    d. Include a screenshot of your finished ModelBuilder model
    e. Screenshot of your map from Task 3 (ModelBuilder results)
    f. Please describe your challenges with the assignment. Where there any steps or tools that were discouraging to use?

Grading Rubric

Grading Criteria (i.e., what am I looking for)

Criteria				
Excellent (A and A-)	***Good (B+, B, B-)***	***Satisfactory (C+, C, C-)***	***Unsatisfactory (D)***	***Poor (F)***
90-100 points All data operations tasks are successful – student was able to load data, create a Python expression, and build a ModelBuilder model, as per assignment instructions The Python expression that was provided had perfect syntax and showed mastery of the language The ModelBuilder screenshot contained all three (3) required tools or more, and the resulting analysis was well thought out. Discussion questions responses are clear and succinct and demonstrate genuine insight the student gained. All assignment directions are followed correctly as specified in the instructions.	**80-89 points** Most data operations tasks are successful – student was able to load data, create a Python expression, and build a ModelBuilder model, per assignment instructions, but some problems were encountered. The Python expression that was provided was working but not 'Pythonic' in nature. The ModelBuilder screenshot contained most of the required tools and the resulting analysis was well thought out. Most assignment directions are followed correctly as specified in the instructions.	**70-79 points** Few data operations tasks are successful – student was not able to create the ModelBuilder model or generate output. The Python expression that was provided was not appropriate or contained significant errors. Many assignment directions were not followed correctly.	**60-69 points** No data operations tasks were successful – student struggled to work with ArcGIS Pro. Maps produced are unreadable and difficult to understand. Did not include screenshots of ModelBuilder or Python expression Many assignment directions were not followed correctly.	**<60 points** No data or maps provided. Assignment directions not followed at all.